Fourth Annual Conference on Carbon Capture & Sequestration

Developing Potential Paths Forward Based on the Knowledge, Science and Experience to Date

Sequestration Policy and Feasibility Studies (1)

Scope for the Deployment of Carbon Capture and Storage Technologies in the UK up to 2020

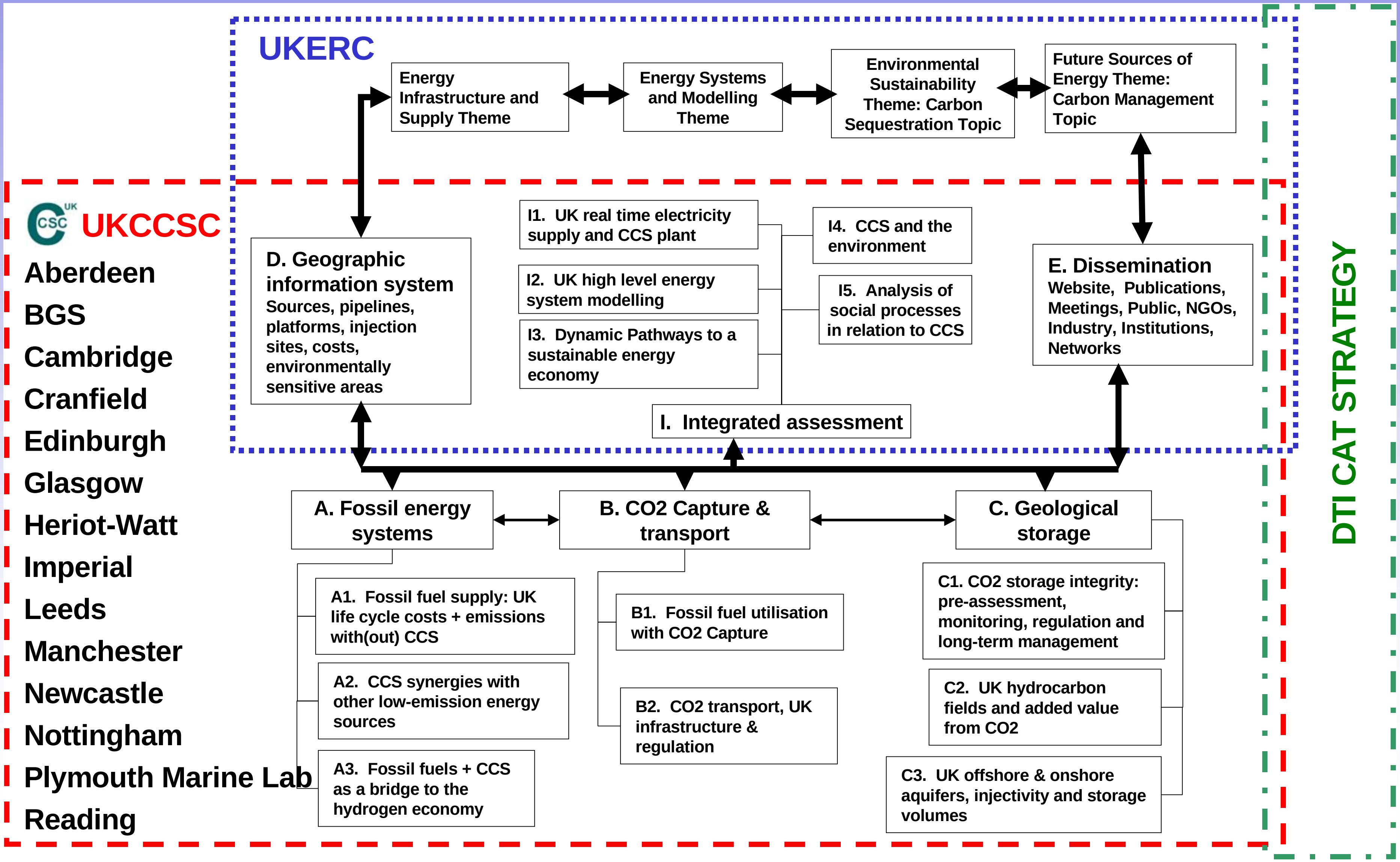
Jon Gibbins, Stuart Haszeldine, Sam Holloway, Jonathan Pearce, John Oakey, Simon Shackley, Carol Turley

May 2-5, 2005, Hilton Alexandria Mark Center, Alexandria Virginia

UK Carbon Capture and Storage Consortium

Linked with UK Energy Research Centre

$3.8M budget, starting mid-2005



Royal Commission on Environmental Pollution
22nd Report: ENERGY – the changing climate
June 2000

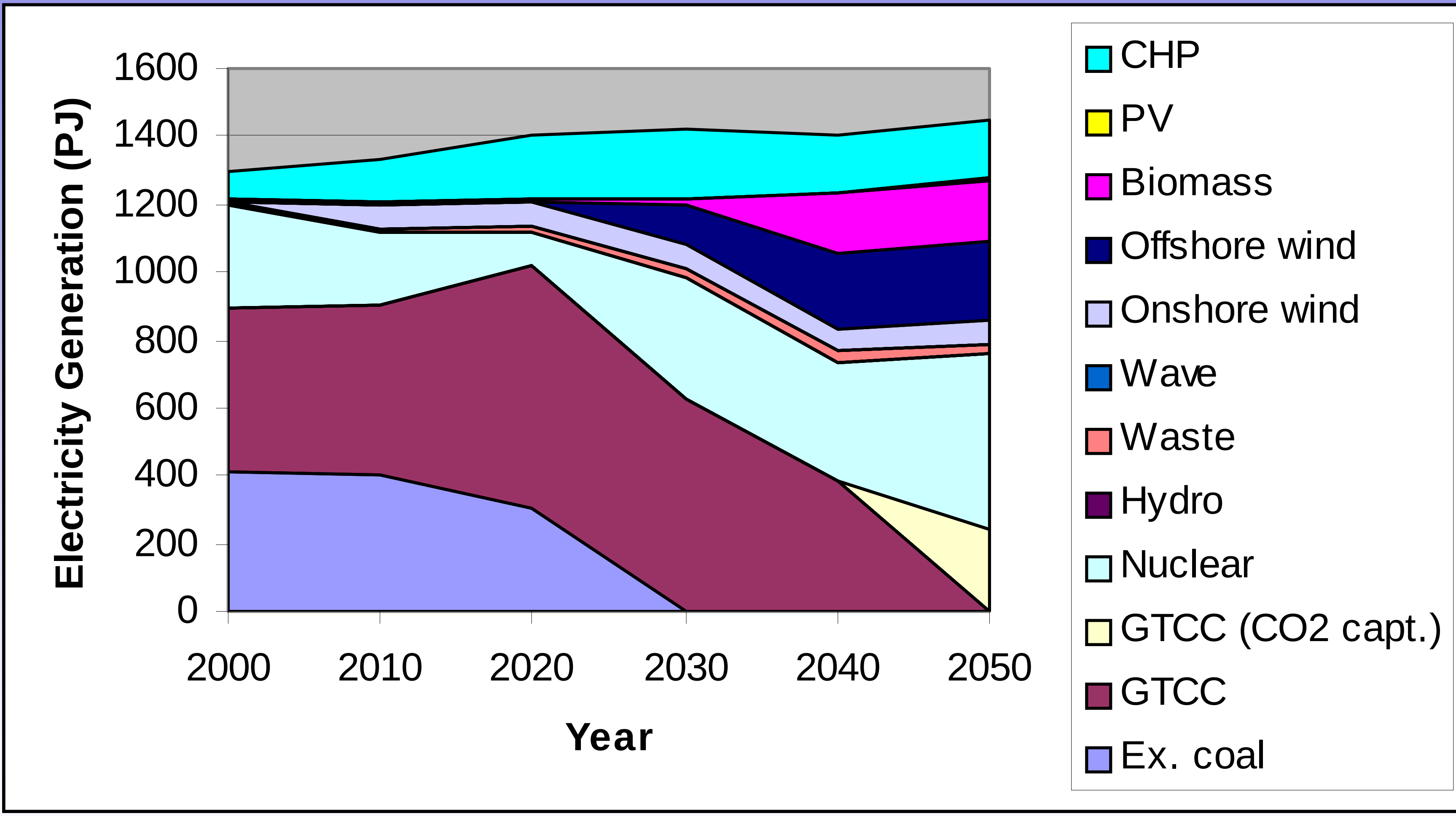
ALTERNATIVE SCENARIOS

We have drawn up four scenarios for energy supply and demand in the UK, on the assumption that ***carbon dioxide emissions from fossil fuel combustion must be reduced by 60% in 2050.***

Two of the scenarios assume a large contribution from ***nuclear power*** *or an equivalent electrical output from large, fossil fuel-burning power stations with* ***carbon dioxide capture and isolation in geological strata.***

The other two have neither nuclear power nor carbon dioxide capture and isolation.

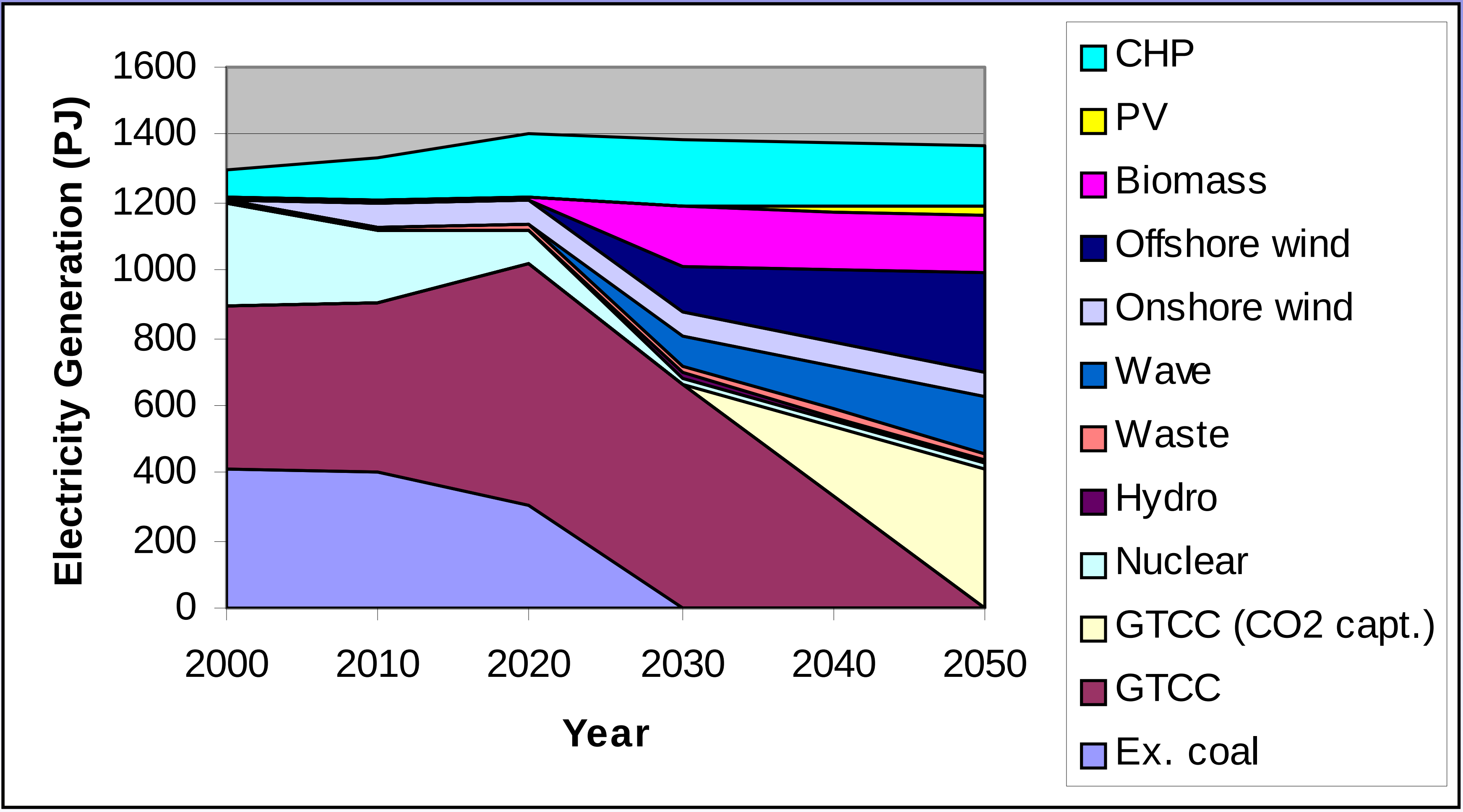
Fuel Mix in Electricity Generation for 60% CO_2 Reduction in 2050
Nuclear 3.0 p/kWh



Based on data from: DTI Economics Paper No. 4, **Options for a Low Carbon Future**, June 2003.
http://www.dti.gov.uk/economics/opt_lowcarbonfut_rep41.pdf
George Marsh, **UK Perspective on CO2 Capture and Storage**, Presentation to the IEA GHG Technical Forum, Wellington, New Zealand, February 2004
http://www.crl.co.nz/events/pdfs/Marsh-IEA.pdf

Jon Gibbins
Imperial, 2004

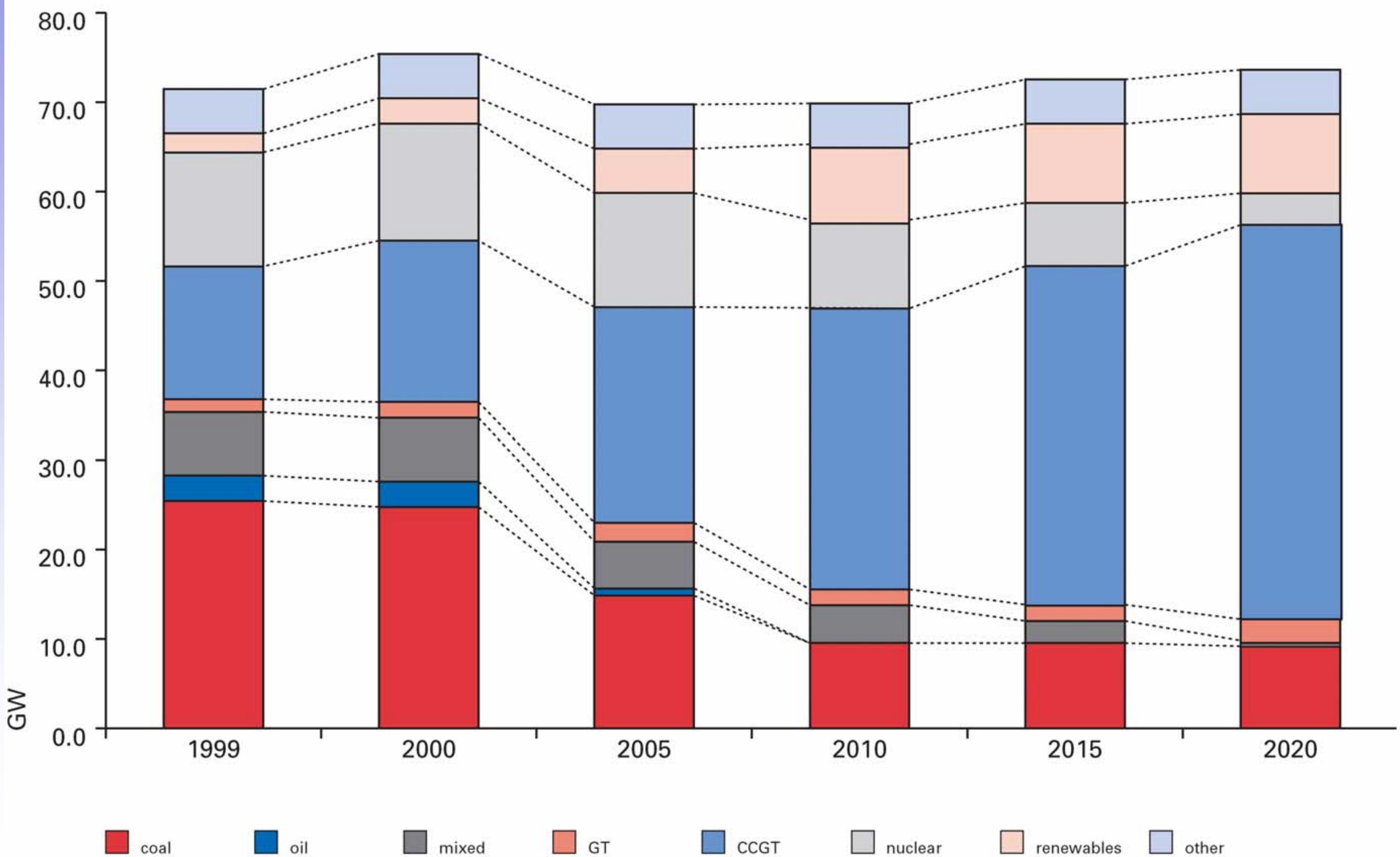
Fuel Mix in Electricity Generation for 60% CO_2 Reduction in 2050
Nuclear 3.5 p/kWh



Based on data from: DTI Economics Paper No. 4, **Options for a Low Carbon Future**, June 2003.
http://www.dti.gov.uk/economics/opt_lowcarbonfut_rep41.pdf
George Marsh, **UK Perspective on CO2 Capture and Storage**, Presentation to the IEA GHG Technical Forum, Wellington, New Zealand, February 2004
http://www.crl.co.nz/events/pdfs/Marsh-IEA.pdf

Jon Gibbins
Imperial, 2004

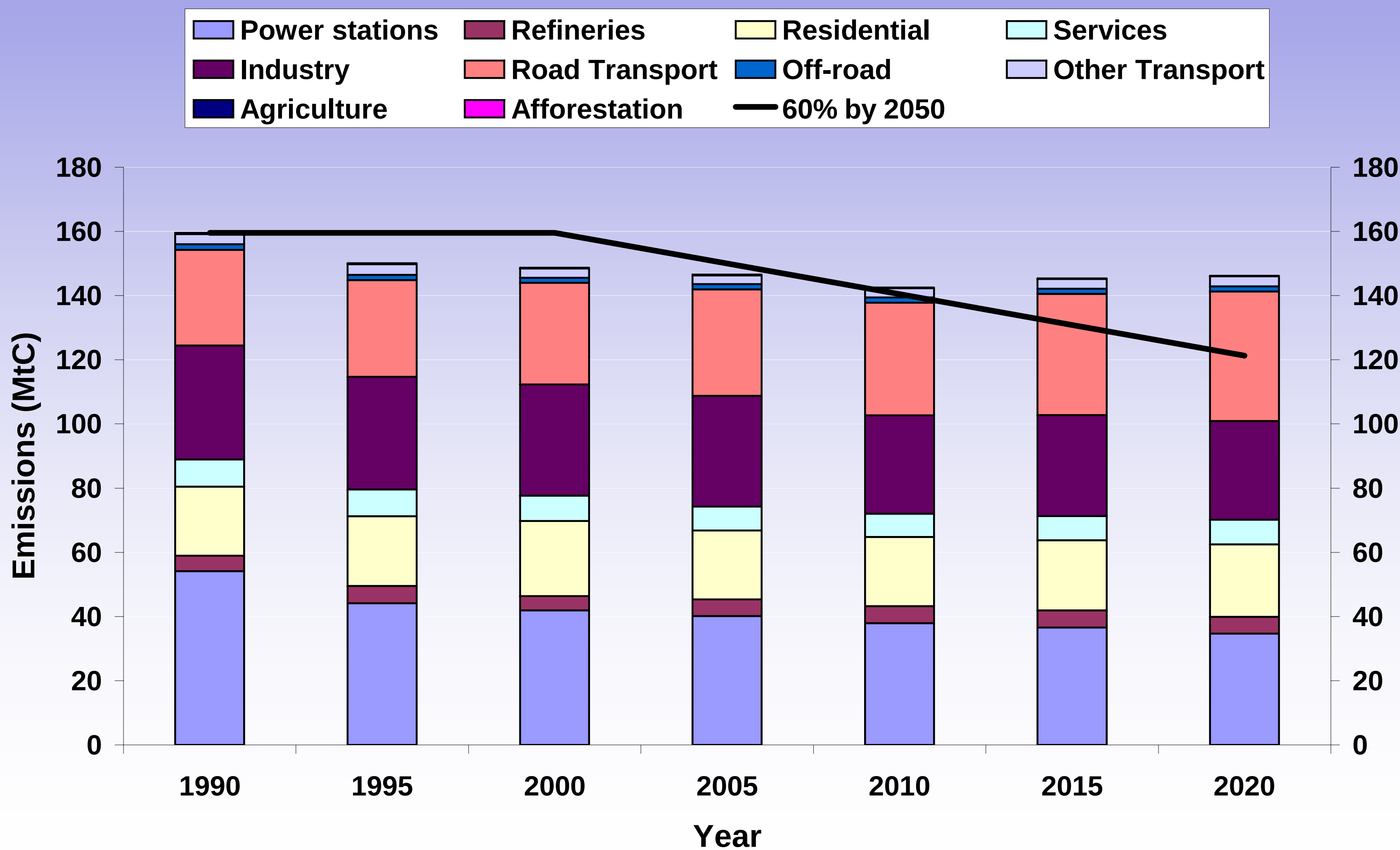
Conventional expectations for new power plant
- all lost coal and nuclear replaced by natural gas combined cycle



DTI, *Energy Paper 68: Energy Projections for the UK*, The Stationery Office, November 2000.

Carbon emissions in the next decade ?

Data from Table 6, Updated UK Energy Predictions, DTI Working Paper, May 2004. (http://www.dti.gov.uk/energy/sepn/uep.pdf)



Using CCS in the electricity sector to help meet the 2020 emissions gap

	ORIGINAL UEP VALUES					ALTERNATIVE 2020 SCENARIOS				
Fuel	Electricity Generation, TWh/yr					No coal, 20% renew-ables	CCS on 2020 coal (90% capture)	CCS on 2010 coal (90% capture)	CCS on gas (85% capture) 2020 coal with no capture	CCS on gas (85% capture) and 2010 coal (90% capture)
	2000	2005	2010	2015	2020	2020	2020	2020	2020	2020
Coal	111.9	113	106	89	57	0	57	106	57	106
Oil	2.1	2	2	2	2	2	2	2	2	2
Gas	127	116	132	159	225	264	207	158	207	158
Nuclear	78.3	84	61	41	27	27	27	27	27	27
Renewables	10.1	15	39	58	58	76	76	76	76	76
Imports	14.3	9	10	10	10	10	10	10	10	10
Pumped storage	2.6	3	3	3	3	3	3	3	3	3
TOTAL	346.3	344	353	362	382	382	382	382	382	382
MtC/yr	41.9	40.1	37.9	36.6	34.6	24.0	20.6	17.7	17.5	5.8
Mt CO2 to storage							56	103	64	152
Low emission power	30%	32%	32%	31%	26%	30%	45%	58%	85%	99%
% gas	37%	34%	37%	44%	59%	69%	54%	41%	54%	41%

UK Capture Technology Options

Pre-combustion capture, hydrogen-rich gas for GTCC

- coal and gas both possible as primary fuel
- over the fence supply (polygeneration)
- conventional integrated gasifier combined cycle
- DTI project for gasification – Jacobs Consultancy UK

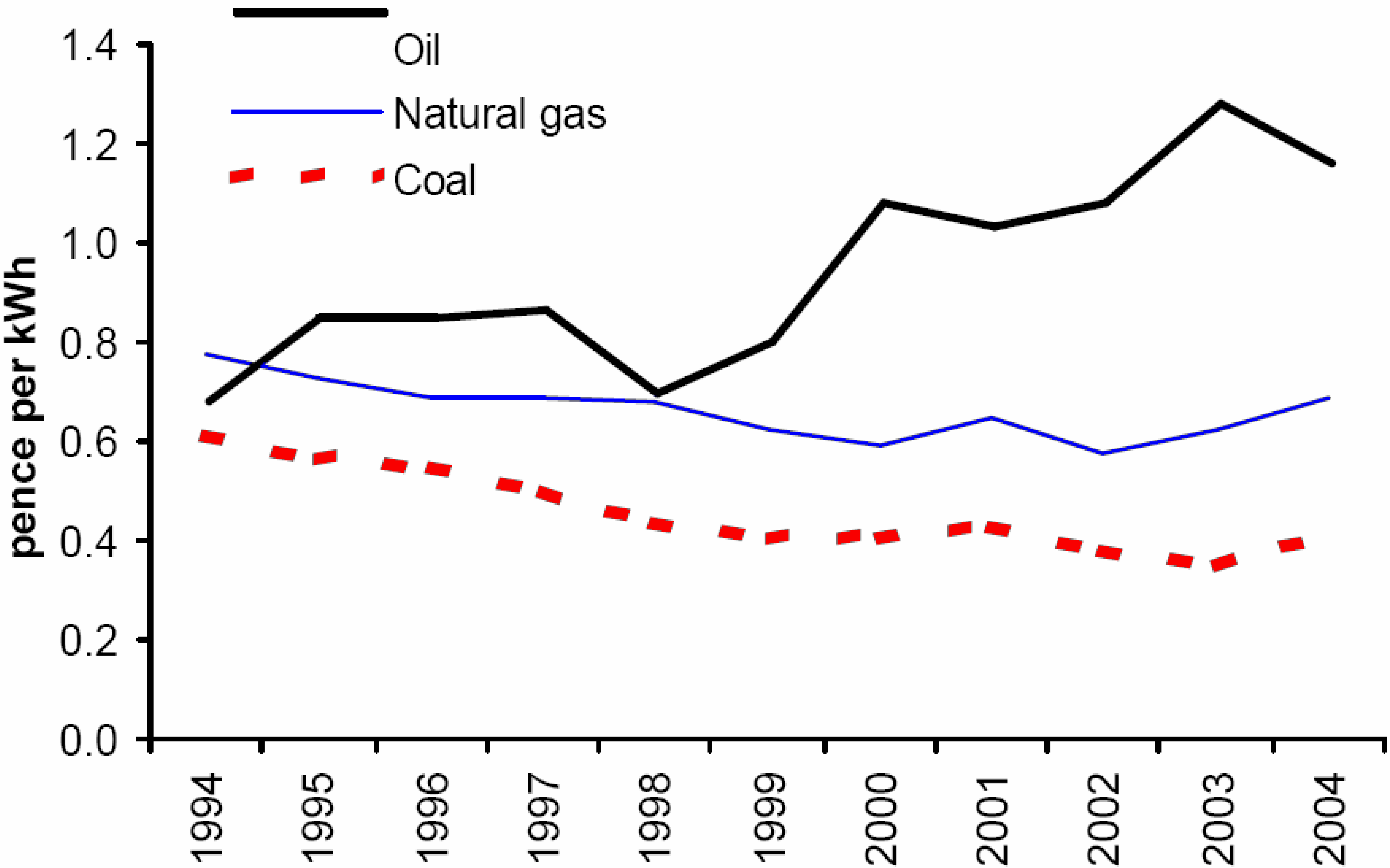
Post combustion capture

- existing PC plant - combined with supercritical retrofit
- DTI project on ASCR with capture – Mitsui Babcock
- GTCC?

Oxyfuel

- existing PC plant - combined with supercritical retrofit
- DTI project – Mitsui Babcock

Average price paid in real terms by UK power producers for coal, oil and natural gas 1994 to 2004



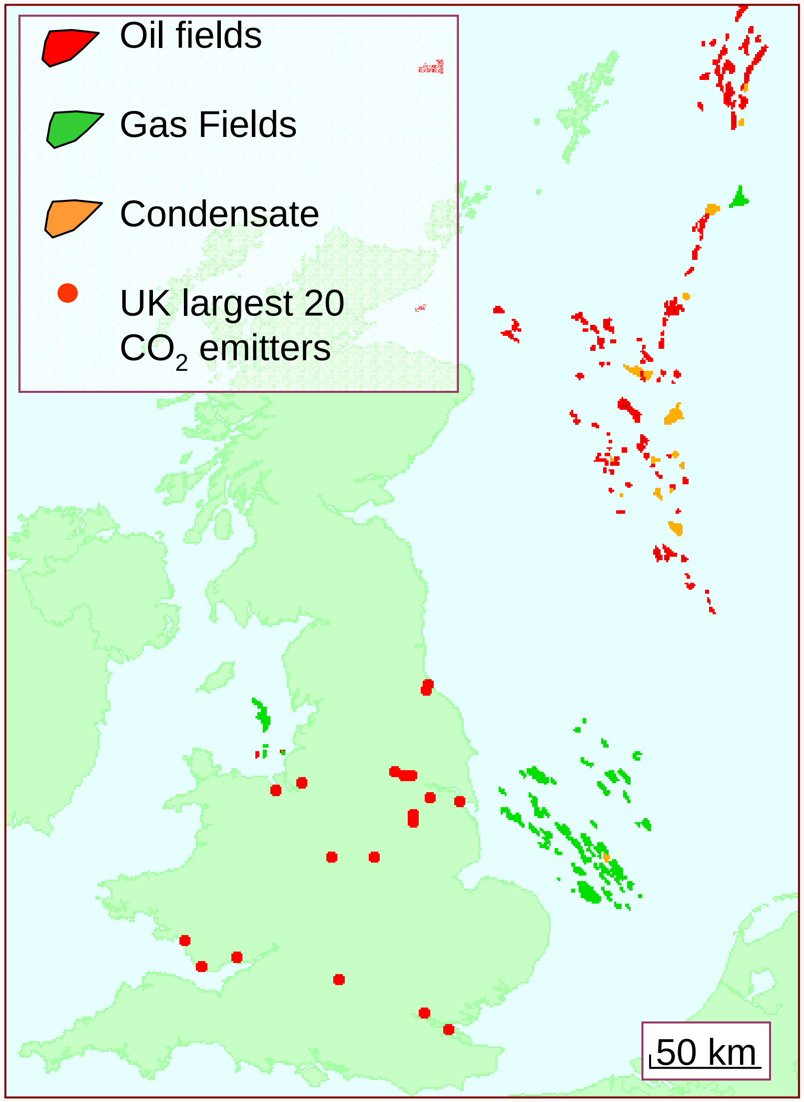
DTI Quarterly Energy Prices March 2005

How much CO_2 could be stored?

- **In the Southern North Sea alone, it has been estimated that a minimum of <u>20 000 Mt</u> of CO_2 can be stored in traps in aquifers, depleted oil and gas fields.**

- **That is <u>200 years</u> worth of storage for UK CO_2 emissions from the top 20 point sources**

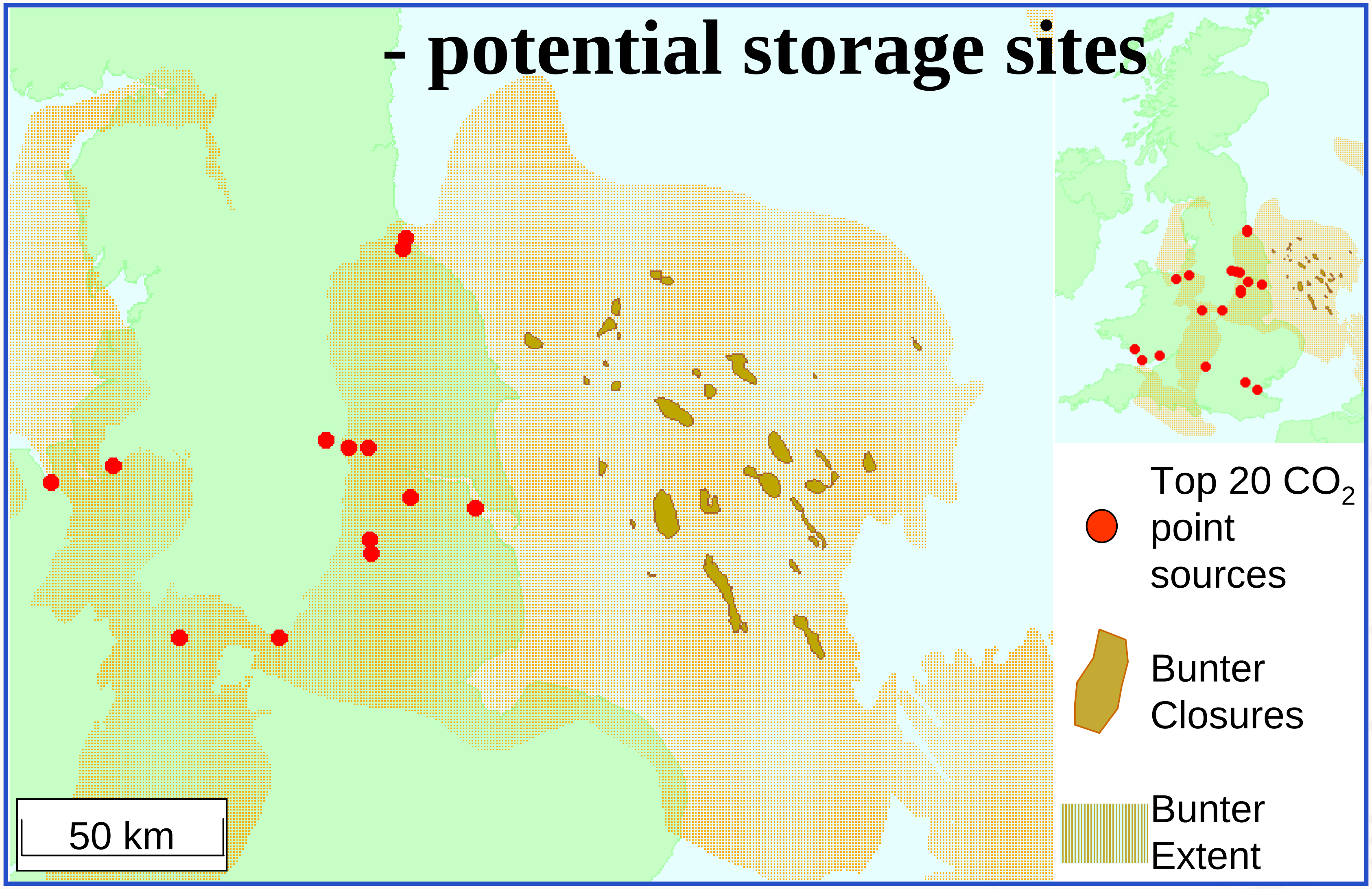
(The authors gratefully acknowledge the contribution of Michelle Bentham, BGS to this section)



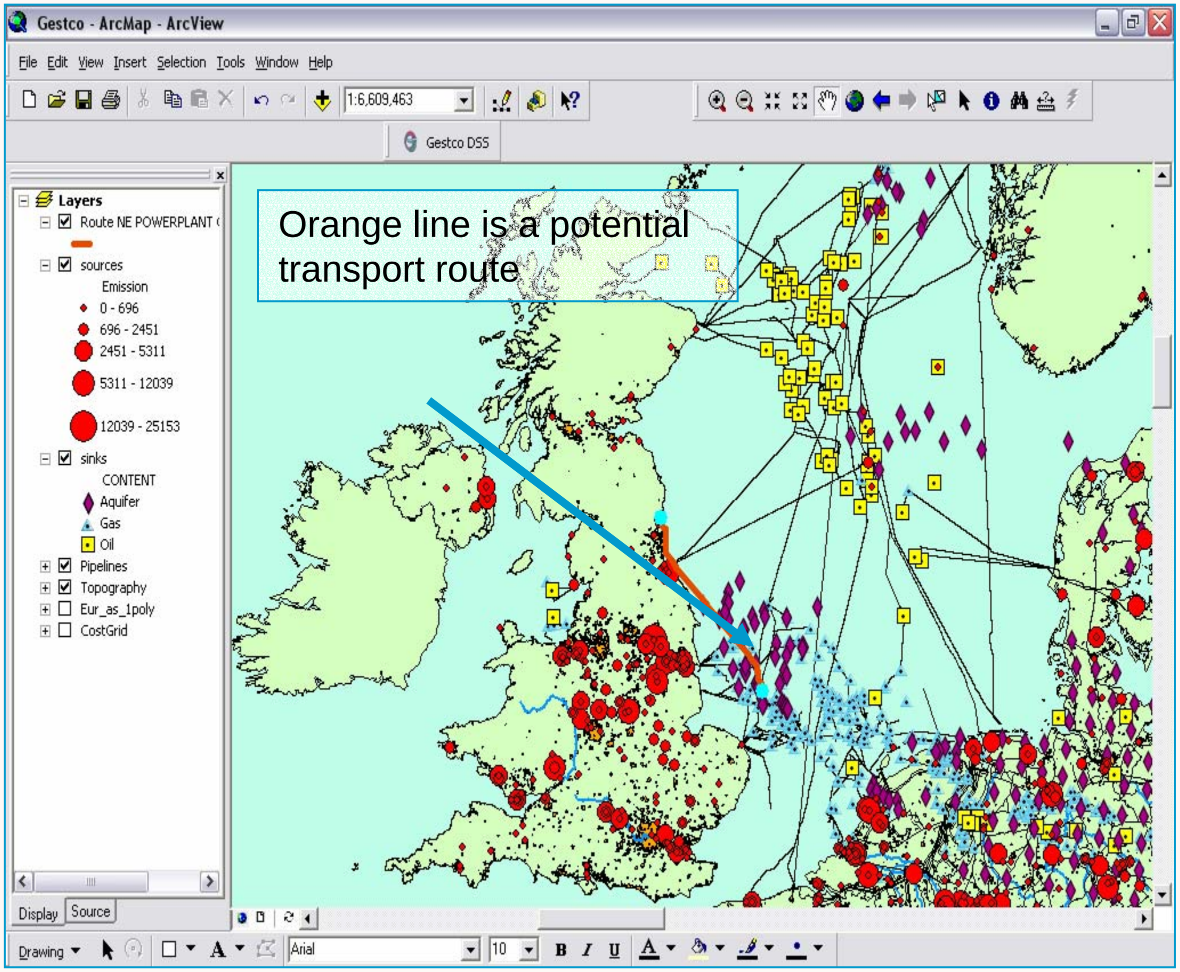
Oil and Gas fields Storage Capacity

- **Theoretical storage capacity of UKCS oil and gas fields:**
- **<u>10 500 $MtCO_2$</u>**

Major closures in the Bunter Sandstone - potential storage sites



Geographical Information System Decision Support System



- **GIS of point sources and sinks for Europe.**
- **An economic tool has been developed (DSS). It examines capture, compression, transport and injection costs.**

Some Barriers to Implementing CCS in the UK

OSPAR and London conventions

- Defra leading on inclusion of geological CO_2 storage

Public acceptability

- CCS probably preferred over nuclear
- Some environmental NGO approval

Financial gap

- ~ 2 c/kWh for capture from gas, 2-4 c/kWh from coal
- ~ \$30 - \$50 tCO_2 abated
- Not clear if reliable economic benefit from offshore EOR
- DTI leading on inclusion of CCS in EU ETS phase 2
- Current EU ETS allowance price \$15-20/tCO_2

Long term policy stability

- Not just a UK issue

UK 2005 Budget Report

7.24 Carbon capture and storage (CCS) is a process by which the carbon in fossil fuels is captured as carbon dioxide and committed to long-term storage in geological formations. It has the potential to significantly reduce carbon emissions from fossil fuel power generation.

It is likely to prove a critical technology in global carbon reduction strategies, particularly for countries with fast growing economies and rapidly growing fossil fuel consumption.

The Government is therefore examining how it might support the development of CCS in the Climate Change Programme Review, including the potential for new economic incentives.

DTI Carbon Abatement Technology Strategy

- Consultation closed 29 October
- Final report delayed by election

Defra UK Climate Change Programme Review

- Report due after the election

Drivers for action

- Power plant closures – old nuclear and coal (EC LCPD)
- CO_2 targets
- Cost – Renewables Obligation Certificate ~ 6c/kWh
- Energy diversity – ‘Keeping the coal option open’?
- Additional benefits from UK offshore assets?

Challenges

- Time!
- New industry to get started